Ref. 2

H9-102939

[Claims]

[Claim 1]

A video transmission equipment comprising:

a first output unit for VSB-AM modulating, multiplexing and outputting an analog video signal having a plurality of channels; and

a second output unit for multilevel-modulating, multiplexing and outputting a digital video signal having a plurality of channels, and further multiplexing signals outputted from said first and second output units and sending them to a transmission line reaching a user terminal, wherein

said second output unit comprises a plurality of multilevel modulation circuits for multilevel-modulating said digital video signal,

said multilevel modulation circuits comprise:

a setting circuit for setting one of multilevel QAM modulation and multilevel VSB-AM modulation as a modulating method to be performed in that multilevel modulation circuit,

a slicer circuit for slicing said digital video signal to a predetermined number of bits and changing the number of bits to be sliced according to a multivalued level of the modulation method set in said setting circuit,

a mapping circuit for dividing and outputting said sliced signal to data signals of Q axis and I axis intersecting to each other, according to the modulation method set by said setting circuit,

a filter circuit provided for each of said data signals, for setting a filter factor to each signal according to the modulation method set by said setting circuit, and band limiting corresponding said data signal based on that filter factor,

a converter circuit provided so as to correspond to said each filter circuit, for converting each data signal outputted from said filter circuit to an analog signal, and

an orthogonal modulation circuit for setting a local oscillation frequency according to said set modulation method and orthogonally modulating an output signal of said both converter circuits using the set local oscillation frequency.

[Claim 2]

The video transmission equipment according to claim 1, characterized in that

when said multivalued level of the multilevel QAM modulation is 2^{2m} (m is a natural number), said slicer circuit slices said digital video signal to m bits and when said multivalued level of the multilevel VSB-AM modulation

is 2^n (n is a natural number), it slices said digital video signal to n bits.

[Claim 3]

The video transmission equipment according to claim 1, characterized in that

said mapping circuit outputs the same data signal to the Q axis and the I axis in the case of multilevel VSB-AM modulation.

[Claim 4]

The video transmission equipment according to claim 1, characterized in that

said filter circuit sets a rolled off and route allocated filter factor for each data signal of Q axis and I axis in the case of the multilevel QAM modulation, and

it sets a rolled off and route allocated filter factor for the data signal of the I axis and sets a rolled off, route allocated and Hilbert transformed filter factor for the data signal of the Q axis in the case of the multilevel VSB-AM modulation.

[Detailed Description of the Invention]

[0001]

[Technical Field to which the Invention Pertains]

The present invention relates to a video transmission equipment of a cable antenna television having a many channels ranging from 100 to 500.

[0002]

[Related Art and Problems to be solved by the Invention]

As a video transmission method of a conventional cable antenna television, a method of converting a signal of an existing broadcast standard to a vestigial sideband amplitude modulation (VSB-AM) signal and frequency-multiplexing and transmitting it is generally used. Many CATV constitutes an image transmission system using this method.

[0003]

In addition, there is proposed a method of frequency-multiplexing a QAM modulated digital image signal to a frequency-multiplexed VSB-AM signal and transmitting a video signal having many channels (Japanese Unexamined Patent Publication No. 4-312088).

[0004]

However, as a multilevel modulation method used when the video signal is multiplexed and transmitted, two kinds of multilevel VSB-AM modulation method and multilevel QAM modulation method have been spread worldwide, so that it is desirable to provide a video transmission equipment which can respond to both modulation methods in response to the future trends.

[0005]

The present invention was made to solve the above

problem and it is an object of the present invention to provide a video transmission equipment comprising a function to be able to respond to both modulation method.

[0006]

[Means to solve the Problems]

Thus, a video transmission equipment according to the present invention comprises a first output unit for VSB-AM modulating, multiplexing and outputting an analog video signal having a plurality of channels, and a second output unit for multilevel-modulating, multiplexing and outputting a digital video signal having a plurality of channels. The second output unit comprises a plurality of multilevel modulation circuits for multilevel-modulating the digital video signal, and the multilevel modulation circuits comprise a setting circuit for setting one of multilevel QAM modulation and multilevel VSB-AM modulation as a modulating method to be performed in that multilevel modulation circuit, a slicer circuit for slicing the digital video signal to a predetermined number of bits and changing the number of bits to be sliced according to a multivalued level of the modulation method set in the setting circuit, a mapping circuit for dividing and outputting the sliced signal to data signals of Q axis and I axis intersecting to each other, according to the modulation method set by the setting circuit, a filter

circuit provided for each of the data signals, for setting a filter factor to each signal according to the modulation method set by the setting circuit, and band limiting the corresponding data signal based on that filter factor, a converter circuit provided so as to correspond to the each filter circuit, for converting each data signal outputted from the filter circuit to an analog signal, and an orthogonal modulation circuit for setting a local oscillation frequency according to the set modulation method and orthogonally modulating an output signal of the both converter circuits using the set local oscillation frequency.

[0007]

Although the number of bits to be sliced varies depending on a multivalued level of each modulation method, when the slicer circuit is constituted as described above, it can respond to the multivalued level designated by either modulation method. In addition, even when either modulation method is designated, since the mapping circuit always divides and outputs each data signal of the Q axis and the I axis, and the orthogonal modulation circuit provided at the subsequent stage always implements the orthogonal modulation, the second output unit can be used for both multilevel VSB-AM and the multilevel QAM.

[0008]

According to the video transmission equipment as set forth in claim 2, when the multivalued level of the multilevel QAM modulation is 2^{2m} (m is a natural number), the slicer circuit slices the digital video signal to m bits and when the multivalued level of the multilevel VSB-AM modulation is 2^{n} (n is a natural number), it slices the digital video signal to n bits. According to the above slicing process, a slicing process can be performed according to the multivalued level of each modulation method.

[0009]

According to the video transmission equipment as set forth in claim 3, the mapping circuit outputs the same data signal to the Q axis and the I axis in the case of multilevel VSB-AM modulation. According to the above outputting, the orthogonal modulation can be implemented by the orthogonal modulation circuit provided at the subsequent stage.

[0010]

According to the video transmission equipment as set forth in claim 4, the filter circuit sets a rolled off and route allocated filter factor for each data signal of Q axis and I axis in the case of the multilevel QAM modulation, and it sets a rolled off and route allocated filter factor for the data signal of the I axis and sets a rolled off, route allocated and Hilbert transformed filter factor for

the data signal of the Q axis in the case of the multilevel VSB-AM modulation. By setting each factor as described above, a filter factor can be set according to each modulation method.

[0011]

[Embodiment of the Present Invention]

An embodiment of the present invention will be described with reference to the accompanying drawings hereinafter.

[0012]

Fig. 1 schematically shows a CATV transmission system comprising a video transmission equipment according to this embodiment. In a CATV station, a center equipment 1 that transmits a video signal having many channels is provided, and the video signal having the many channels outputted from the center equipment 1 is transmitted to a main transmission area through a fiber-optic cable 2. The optical signal transmitted through the fiber-optic cable 2 is converted to an electric signal by an O/E converter 3 and then transmitted to a target area through a coaxial cable 4 laid out in a plurality of lineages. A splitter 5 (tap-off) is connected to the coaxial cable 4 and connected to a terminal equipment 6 of each user through the splitter 5. In addition, a dendritic network is constituted by dependently connecting the coaxial cables

4 through a bidirectional relay amplifier 7, so that a video transmission service is provided to many users.

[0013]

As shown in Fig. 2, this transmission system has a large transmission band from 5MNz to 700 MHz in which a band of 6 MHz is used per channel, for example, and the low-frequency band of 5 MHz to 30 MHz is used for an uplink to transmit a data signal from each terminal equipment 7 to the center equipment 1. In addition, a high-frequency band of 50 MHz to 700 MHz is used for a downlink to transmit existing TV broadcast as a basic service as well as various kinds of video signals of a pay channel of the CATV, PPV (Pay Per View) and the like.

[0014]

In addition, similar to a conventional technique, each bidirectional relay amplifier 7 compensates a transmission loss and information of the compensating state or information of an inside state thereof (failure state of an inner power supply, or environmental states of a temperature, moisture and the like) are sequentially transmitted to the center equipment 1 using a predetermined channel of the uplink as a status signal ST.

[0015]

Next, an essential constitution of the center equipment 1 is shown in Fig. 3. The center equipment 1

comprises an analog signal generation unit 110 and digital signal generation units 120 and 130 and the like as circuits for generating the video signal.

[0016]

The analog signal generation unit 110 has a main function to generate a video signal of existing TV broadcast and satellite broadcast which are the basic service of the CATV, and it comprises a VSB-AM modulator 111 for VSB-AM modulating each analog video signal of each channel, a frequency converter 112 for converting a frequency such that the modulated video signal of each channel can be adapted to channel arrangement of the CATV system, a frequency multiplexer 113 for multiplexing the frequency-converted signal of each channel, and a level adjuster 114 for adjusting the multiplexed signal level.

[0017]

The digital signal generation unit 120 has a function to generate a video signal of the above-described pay channel and the like for a user having the terminal equipment 6 that responds to a multilevel QAM signal and comprises a multilevel QAM modulator 121 for multilevel-QAM modulating the digital video signal of each channel, a frequency converter 122 for converting a frequency so that the multilevel-modulated video signal of each channel can be adapted to channel arrangement of

the CATV system, a level adjuster 123 for adjusting a level of the frequency-converted video signal, and a frequency multiplexer 124 for multiplexing the signal of each channel.

[0018]

The digital signal generation unit 130 has a function to generate a video signal of the above-described pay channel and the like for the user having the terminal equipment 6 that responds to a multilevel VSB-AM signal and comprises a multilevel VSB-AM modulator 131 for multilevel VSB-AM modulating the digital video signal of each channel, a frequency converter 132, a level adjuster 113, and a frequency multiplexer 134.

[0019]

In addition, a digital video signal that was multiplexed by a digital signal time multiplexer 140 is supplied to the digital signal generation units 120 and 130, and the analog signal generation unit 110 and the digital signal generation units 120 and 130 are controlled by a center controller 150.

[0020]

Furthermore, the center equipment 1 comprises a directional filter 13 for receiving an uplink data signal D_U transmitted from the terminal equipment after separating it from a band of the uplink, and a receiver

14 for demodulating the uplink data signal D_U and the like and transmitting the demodulated data D_M to the center controller 150. In addition, a database system 15 for transmitting and receiving network management data and the like about whether user sets the QAM type or the VSB-AM type of the terminal equipment and the like with an incorporated computer system is connected to the center controller 150.

[0021]

Here, a description will be made of constitutions of the multilevel QAM modulator 121 and the multilevel VSB-AM modulator 131 which are the multilevel modulators of the digital signal generation units 120 and 130. The multilevel modulators 121 and 131 have the same circuit constitution as will be described below and each of them comprises a switching circuit 200 for switching the modulation method used at the multilevel modulator between the QAM modulation and VSB-AM modulation, so that one multilevel modulation circuit can respond to the two modulation methods (QAM modulation and the VSB-AM modulation).

[0022]

A main part of each of the multilevel modulators 121 and 131 is constituted as shown in Fig. 4.

[0023]

A slicer circuit 201 is a circuit for slicing (slicing process) a transmission bit sequence applied as the digital video signal to data having the predetermined number of bits, although the number of bits varies depending on a multivalued level designated by a multivalued level control signal supplied from the center controller 150. For example, in a case of the QAM modulation having a multivalued level of 16, the data is sliced to 2 bits and in a case of the multilevel VSB-AM modulation having a multivalued level of 16, the data is sliced to 4 bits. In general, when the multivalued level of the multilevel QAM modulation is 2^{2m} (m is a natural number), the data is sliced to m bits, and when the multivalued level of the VSB-AM modulation is 2^n (n is a natural number), the data is sliced to n bits. In the case of the multilevel VSB-AM modulation, the sliced data obtained by the slicing process is formed in a predetermined frame and applied to a mapper circuit 202. In addition, in the case of the multilevel QAM modulation, the transmission bit sequence applied as the digital video signal is formed in a predetermined frame and it is applied to the slicer circuit 201 and sliced to the number of bits corresponding to the multivalued level as described above, and the sliced data obtained by the slicing process is applied to the mapper circuit 202.

[0024]

Although the mapper circuit 202 divides the framed data signal into bit data of an I axis and Q axis and outputs it, this process contents vary depending on the modulation method designated by the switching circuit 200. When the QAM modulation is designated by the switching circuit 200, multivalued level conversion is performed by converting the supplied data signal to I axis data D_I of M/2 and Q axis data D_Q of M/2 separately when the bit number M is designated by the center controller 150. In addition, when the VSB-AM modulation is designated by the switching circuit 200, two's complementary operation and the like is performed to output the same data for the I axis and Q axis.

[0025]

FIR filter circuits 203Q and 203I are provided corresponding to two data signals of the Q axis and the I axis outputted from the mapper circuit 202, respectively, and a factor setting circuit 204 selectively sets a filter factor for the FIR filter circuits 203Q and the 203I according to each modulation method. When the QAM modulation is designated by the switching circuit 200, a rolled off and route allocated filter factor "a" is set for the FIR filter circuits 203Q and 203I. Meanwhile, when the VSB-AM modulation is designated by the switching circuit 200, the rolled off and route allocated filter

factor "a" is set for the FIR filter circuit 203I of the I axis, and a rolled off, route allocated and Hilbert transformed filter factor "b" is set for the FIR filter circuit 203Q of the Q axis.

[0026]

Thus, in each of the filter circuits 203Q and 203I in which the filter factors are set individually, the baseband of the data signal transmitted from the mapper circuit 202 is limited.

[0027]

In either modulation method, the data signal transmitted from each of the filter circuits 203Q and 203I is converted to the analog signal by a D/A conversion circuit 205 and then orthogonally modulated by an orthogonal modulator 206. At this time in order to uniform an intermediate frequency, a local frequency setting circuit 207 for setting a local frequency of the orthogonal modulator 206 according to the modulation method is provided, and appropriate local frequency IF1 or IF2 is set according to the modulation method designated by the switching circuit 200. The orthogonally modulated signal here is applied to the frequency converters 112 and 122 (Fig. 3).

[0028]

In addition, a RSC (Symbol Rate Clock) circuit 208

for applying a clock signal responding to each modulation method to a predetermined circuit is provided, and when the multilevel QAM modulation is designated by the switching circuit 200, a symbol rate clock SRC1 is selected, and when the multilevel VSB-AM modulation is designated by the switching circuit 200, a symbol rate clock SRC2 is selected. Each of the selected clock signals is applied to each clock terminal of the slicer circuit 201, the mapper circuit 202, the filter circuits 203Q and 203I, and the D/A conversion circuit 205 and each circuit operates at a timing according to the set clock signal.

[0029]

As described above, each of the multilevel modulators 121 and 131 has a function that can respond to both QAM modulation and VSB-AM modulation, and the QAM modulation is implemented at a multilevel modulator set in the digital signal generation unit 120 and the VSB-AM modulation is implemented in the digital signal generation unit 130 under control of the switching circuit 200.

[0030]

Thus, the multilevel digital signals having many channels modulated by the digital signal generation unit 120 and the digital signal generation unit 130 and the analog modulated signals having many channels outputted from the analog signal generation unit 110 are

frequency-multiplexed and transmitted to the terminal equipment 6 through the fiber-optic cable 2 based on the frequency arrangement shown in Fig. 2.

[0031]

As a main transmission path used in this transmission, the fiber-optic cable 2 is used in view of its transmission distance, band and picture quality. Three kinds of signal levels that are to be inputted to the fiber-optic cable 2 are adjusted by the signal generation units 110, 120 and 130 so that modulation degrees that satisfy an SN required when received can be applied to a laser diode LD serving as a light emitting source. According to the signal level at this time, the analog VSB-AM modulated signal which is for the basic service such as the existing TV broadcast is adjusted to be at a level for applying a great modulation degree, and the multilevel digital modulated signal which is for another service such as pay broadcast is adjusted to be at a level for applying a small modulation degree (Fig. 2).

[0032]

Next, the terminal equipment 6 provided for the user will be described. In addition, there are two kinds, that is, a VSB demodulation type that demodulates the VSB-AM modulated signal and a QAM demodulation type that demodulates the QAM modulated signal in the terminal

equipment 6. The user has the terminal equipment 6 comprising either one of the above demodulation methods.

[0033]

First, the VSB demodulation type of terminal equipment will be described with reference to Fig. 5. A tuner 41 connected to a directional filter 40 that separates a frequency band to the downlink and the uplink converts a downlink data signal D_L to an IF signal. A VSB demodulation lineage to obtain original main video data D_{in} and a failure detection lineage to detect an abnormal network are connected to an output of the tuner 41.

[0034]

According to the proper VSB demodulation lineage, the IF signal is demodulated by a VSB demodulator 42 and converted to digital data by an A/D converter 43 and a baseband signal is outputted, and then an equalizer 44 performs an equalization process to the baseband signal. Then, an error correction circuit 45 corrects a code error generated on the network and generates demodulated data D_{RV} that is the same as the main video data D_{in} and transmits it to a communication control circuit 53.

[0035]

Meanwhile, the failure detection lineage comprises a VSB demodulator 46, an A/D converter 47, an equalizer 48 and an error correction circuit 49 having the same

constitutions as those of the VSB demodulator 42, the A/D converter 43, the equalizer 44 and the error correction circuit 45, and further comprises a reflection distortion calculation circuit 50 for calculating a reflection distortion of the network based on the filter factor of the equalizer 48, an S/N calculation circuit 51 for calculating a S/N of an output signal X of the equalizer 48, and an error rate calculation circuit 52 for calculating a transmission error rate from a correction result of the error correction circuit 49. Then, operation data E_1, E_2, and E_3 founded by the reflection distortion calculation circuit 50, the S/N calculation circuit 51 and the error rate calculation circuit 52 are supplied to the communication control circuit 53.

[0036]

Here, as the equalizers 44 and 48, a transversal digital filter and the like having a predetermined tap number "m" is employed, for example, and each of them mainly equalizes reflection distortion by appropriately adjusting each filter factor using a difference between a VSB demodulated frame synchronization signal and ideal frame synchronization signal. Thus, the reflection distortion calculation circuit 50 calculates an arrival time T of the reflection distortion and a reflection distortion level H by finding a mutual correlation between

actual values of the filter factor (y_1, y_2, y_3 … y_m) and previously known values in an ideal state (ya_1, ya_2, ya_3 … ya_m) of the equalizer 48. For example, as shown in Fig. 6, when a value y_j of the j-th filter factor is largely different from a value ya_j in the ideal state, a time ($j \times \tau$) j times as long as a sampling cycle τ determined by a sampling theorem is found as the arrival time T of the reflection distortion, and a difference between the value y_j of the j-th filter factor and a value y_{j+1} of the (j+1)th filter factor is found as the reflection distortion level H.

[0037]

The S/N calculation circuit 51 finds an S/N by calculating a ratio η between true data contained in a predetermined period in each frame (referred to as the reference period hereinafter) T_b and data of a noise component. This principle will be described with reference to Fig. 7. In order to describe the principle easily, an analog signal which is equivalent to a digital signal X is used. The reference period T_b as well as data corresponding to the main video data D_{in} and a period T_a for transferring the synchronous data and the like are previously set in each frame, and this reference period T_b contains a none signal period τ_b and an inspection signal S_p having a predetermined amplitude, which are transmitted

as reference data of the addition data D_{CK}.

[0038]

The S/N calculation circuit 51 measures a signal in the reference period T_b and since only the inspection signal S_p is measured in an ideal state in which a noise and the like does not exist as shown by the signal X in Fig. 7, a high S/N is found. Thus, information data (X_i; where i is a sample timing) of the ideal signal X during the reference period T_b is previously stored and a square error $\Sigma(X_i-X_i')^2$ between an actual signal X_i' in the reference period T_b and the information data X_i is calculated and it is divided by a peak amplitude V_{p-p} of the signal X_i', whereby the S/N is found. That is, the S/N is found by $\eta = \Sigma(X_i-X_I')^2/V_{p-p}$.

[0039]

The error rate calculation circuit 52 calculates an error rate using a rate (B_e/B_t) of total bit number B_t to an error bit number B_e found by the error correction circuit 49 and the like.

[0040]

Then, the operation data E_1, E_2 and E_3 found by those calculation circuits 50, 51 and 52 are sequentially supplied to the communication control circuit 53 and failure detection data is formed.

[0041]

The communication control circuit 53 transfers the demodulated data D_{RV} outputted from the VSB demodulation lineage to a television monitor and the like, and forms demand data to be sent to the center equipment through an operation on a keyboard (not shown) and the like provided in the terminal equipment by a user, or forms failure detection data comprising the above operation data E_1, E_2 and E_3 and transfers the above data to a transmitter 54 as the uplink data signal D_U. Then, the transmitter 54 performs a predetermined modulating process and band-converts it to a predetermined uplink channel and transmits it through the direction filter 40.

[0042]

Next, the terminal equipment of the QAM demodulation method will be described with reference to Fig. 8. A tuner 81 connected to a directional filter 80 that separates a downlink frequency band from an uplink frequency band converts the downlink data signal D_L to an IF signal. A QAM demodulator 82 that generates an I axis baseband signal S_I and a Q axis baseband signal S_Q by QAM-demodulating the IF signal is connected to the tuner 81. The I axis baseband signal S_I is converted to digital data by an A/D converter 83_I and equalized by an equalizer 84_I and a code error generated on the network is corrected by an error correction circuit 85_I and supplied to a synthetic circuit

86. Meanwhile, the Q axis baseband signal S_Q is converted to digital data by an A/D converter 83_Q and equalized by an equalizer 84_Q and a code error generated on the network is corrected by an error correction circuit 85_Q and supplied to the synthetic circuit 86. The synthetic circuit 86 synthesizes the baseband signals of the I axis and the Q axis and forms demodulated data D_{RV} corresponding to the main video data D_{in} and transfers it to a communication control circuit 87.

[0043]

The terminal equipment further comprises a reflection distortion calculation circuit 88 for calculating reflection distortion of the network based on the filter factors of the equalizers 84_I and 84_Q comprising a transversal digital filter having a predetermined tap number "m" and the like, an S/N calculation circuit 89 for calculating an S/N of each of outputs X_I and X_Q of the equalizers 84_I and 84_Q, and an error rate calculation circuit 90 for calculating a transmission error rate from a correction result of each of the error correction circuit 85_I and 85_Q and operation data E_1 , E_2 and E_3 founded by the calculation circuits 88, 89 and 90 are supplied to the communication control circuit 87.

[0044]

Here, the equalizers 84_I and 84_Q mainly equalize the

reflection distortion by appropriately adjusting each filter factor using a difference between the actually QAM-demodulated baseband signals of the I axis and the Q axis and ideal baseband signals of the I axis and the Q axis. Thus, the reflection distortion calculation circuit 88 calculates an arrival time T of the reflection distortion and a reflection distortion level H by finding a mutual correlation between the actual values (y_{I1}, y_{I2}, y_{I3}, ... y_{Im}) of the filter factor of the equalizer 48_I and previously known ideal values (ya_{I1}, ya_{I2}, ya_{I3}, ... ya_{Im}) of the same, and a mutual correlation between the actual values (y_{Q1}, y_{Q2}, y_{Q3}, ... y_{Qm}) of the filter factor of the equalizer 48_Q and previously known ideal values (ya_{Q1}, ya_{Q2}, ya_{Q3}, ... ya_{Qm}) of the same and the like. The calculating principle of the arrival time T and the reflection distortion level H is the same as the case of the VSB modulation shown in Fig. 6.

[0045]

The S/M calculation circuit 89 finds an S/N by calculating a rate η between true data contained in the predetermined reference period T_b of the outputs X_I and X_Q of the equalizers 84_I and 84_Q and data of a noise component based on the same principle as that described with reference to Fig. 7.

[0046]

The error rate calculation circuit 90 calculates an error rate by calculating a rate (B_{Ie}/B_{It}) of total bit number B_{It} to an error bit number B_{Ie} found by the error correction circuit 85_{I}, by calculating a rate (B_{Qe}/B_{Qt}) of total bit number B_{Qt} to an error bit number B_{Qe} found by the error correction circuit 85_{Q}, and the like.

[0047]

Then, the operation data E_1, E_2 and E_3 found by those calculation circuits 88, 89 and 90 are sequentially supplied to the communication control circuit 87 and failure detection data is formed.

[0048]

The communication control circuit 87 transfers the demodulated data D_{RV} outputted from the QAM demodulation linage to a television monitor and the like, and forms demand data to sent to the center equipment through an operation on a keyboard (not shown) and the like provided in the terminal equipment by a user, or forms failure detection data comprising the above operation data E_1, E_2 and E_3 and transfers the above data to a transmitter 91 to transmit the data as the uplink data signal D_U. Then, the transmitter 91 performs a predetermined modulating process and band-converts it to a predetermined uplink channel and transmits it through the directional filter 80.

[0049]

Here, an operation of the CATV transmission system constituted as described above will be described. The center controller 150 in the center equipment 1 controls the analog signal generation unit 110 and the digital signal generation units 120 and 130 to convert the main video data D_{in} to the downlink data signal D_L of a predetermined channel and multiplexes it, and frequency-multiplexes the signals from the generation units 110, 120 and 130 (Fig. 2) and transmits them to each terminal equipment through the fiber-optic cable 2 and the coaxial cable 4. In addition, at the same time, it receives the uplink data signal D_U transmitted from the terminal equipment through the uplink, through the receiver 14. Meanwhile, the terminal equipment obtains the demodulated data D_{RV} from the demodulation lineages shown in Figs. 5 and 8 to get information source from the center equipment, and at the same time, the reflection distortion calculation circuit 50 (88), the S/N calculation circuit 51 (89) and the error rate calculation circuit 52 (90) in the failure detection lineage detect a failure and the failure defection information is put in the uplink data signal D_U and transmitted to the center equipment 1.

[0050]

The center controller 150 sequentially compares

failure determination reference data previously stored in the database 15 with failure detection data contained in the uplink data signal D_U to determine a failure state that does not satisfy a predetermined reference value. For example, as shown by slanted lines in Fig. 9, a white noise N1 is mixed in the transmitted signal in general. However, when the coaxial cable 4 (refer to Fig. 1) is cracked and the like, cutoff characteristics at that part deteriorates and a noise is likely to be mixed in. Thus, when the frequency band in which a noise N2 is mixed in addition to the white noise N1 is used in the digital transmission, an SN ratio is lowered and its error rate considerably deteriorates (Fig. 10), and that frequency band cannot be used any more. Therefore, the center controller 150 performs the following response processes.

[0051]

(First process)

First, a channel that is not used at the moment is searched in the frequency band that is used in the downlink. Then, a strobe data comprising a predetermined data pattern is modulated by the digital signal generation units 120 and 130 and this modulated data is sequentially transmitted to the terminal equipment 6 through an unused channel. At the same time, the center controller 150 sequentially obtains the failure detection data in the uplink data

signal D_U transmitted from the terminal equipment 6 and compares it with the failure determination reference data stored in the database 15 to determine whether there is a failure or not in each unused channel. Then, when the center controller 150 detects a normal channel, it supplies a transmission channel control signal S_{CH} to designate a proper channel to a RF converter 208 to switch the channel so that the downlink data signal D_L is transmitted by a carrier frequency f_K of a normal channel (Fig. 9).

[0052]

By performing the above channel switching control, information of the switched channel is transmitted to the terminal equipment to order the switching of the channel, and even when repairing and the like is being performed at a failure generation field by a maintenance personnel or the like, the downlink data signal D_L can be transmitted to the terminal equipment normally, so that a damage of the network can be minimized.

[0053]

(Second process)

Even when it is recognized that the quality of the channel used at the moment deteriorates, there is a case where it is determined that the quality is not so bad to perform the above channel switching control. In this case, a multivalued level control signal S_{LV} is applied to the

slicer circuit 201 and the like and a multivalued level used at the moment is switched to a lower multivalued level. For example, when it is assumed that a downlink data signal D_L by in a 16VSB mode is transmitted at the moment, the multilevel number is reset to a lower 8VSB mode and the like and the downlink data signal D_L is transmitted. Although the multilevel number is determined according to a tradeoff among a noise, interference or transmission speed, the more the multilevel number, the more it is affected by a noise or deterioration in general, so that it becomes difficult to determine a level of the signal received by the terminal equipment.

[0054]

Therefore, in a case where the terminal equipment detects the quality deterioration due to lowering of the S/N and the like, when it lowers the multivalued level by the multivalued level conversion control, noise tolerance can be improved and high-quality information can be provided to the user on the side of the terminal equipment.

[0055]

(Third process)

By collecting the failure detection data contained in the uplink data signal D_U, and processing a predetermined failure generation place determination program, the failure generation place is estimated. By collecting and

statistically processing the operation data E_2 outputted from the S/N calculation circuits 51 and 89 among the failure detection data transmitted from each terminal equipment, it can be determined which transmission path to the terminal equipment has many noises, or by collecting and statistically processing the operation data E_1 outputted from the reflection distortion calculation circuits 50 and 88, it can be determined which transmission path to the terminal equipment has reflection distortion, and a reflection distortion generating place in the failure generated path can be determined. In addition, in order to make the above determination, the kinds of failure generations are previously patterned and stored in the database 15 and by comparing the patterned data with the data provided from the above statistic processing, the above determination is made or the contents of the failure generation is displayed in a display 16.

[0056]

(Fourth process)

When the optical signal is transmitted through the fiber-optic cable 2, the laser diode LD is used as its light emitting source. Although a light emitting level of the laser diode LD varies depending on a current change, when this current exceeds a predetermined threshold value, the distortion is rapidly increased and a picture quality

rapidly deteriorates as shown in Fig. 11. In this state, a distortion level N3 added to the white noise N1 becomes considerably raised as shown in Fig. 12, and transmission characteristics considerably deteriorates due to this distortion. Therefore, the center controller 150 measures the distortion level of the laser diode LD and when the distortion level is high, it controls and lowers an output power of the laser diode LD, so that an influence by the distortion can be prevented from occurring.

[0057]

According to the CATV transmission system as described above, since the terminal equipment can sequentially detect a failure of the network and transmits it to a network managing part 10 of the center equipment, centralized management can be implemented and since information actually determined as a failure by the terminal equipment is transmitted, highly appropriate centralized management can be implemented.

[0058]

Although in the terminal equipment shown in Fig. 5, the normal VSB modulation lineage and the failure detection lineage for detecting the failure are separately provided in the above embodiment, the constitution can be simplified by connecting an equalizer 44 and an error rate correction circuit 45 of a normal VSB modulation lineage to a refection

distortion calculation circuit 50, an S/N calculation circuit 51 and an error rate calculation circuit 52 as shown in Fig. 13. In addition, this simplification of the circuit constitution can be applied also to the terminal equipment shown in Fig. 8.

[0059]

[Effect of the Invention]

As described above, according to a video transmission equipment according to each claim, since it comprises a second output unit that can respond to both multilevel VSB-AM modulation and multilevel QAM modulation, even when different types of user terminal equipments for a QAM demodulation method and for a VSB demodulation method are mixed in the same transmission network, the demodulation method of the video transmission equipment can be easily changed according to increase and decrease in number of users of each method.

[Brief Description of the Drawings]

[Fig. 1]

It is a system constitution view schematically showing a constitution of a CATV transmission system comprising a video transmission equipment according to this embodiment.

[Fig. 2]

It is an explanatory view showing a transmission band

of each transmitted signal.

[Fig. 3]

It is a block diagram showing a constitution of a center equipment.

[Fig. 4]

It is a block diagram showing a constitution of a multilevel modulator (multilevel QAM modulator and multilevel VSB-AM modulator).

[Fig. 5]

It is a block diagram showing a constitution of a terminal equipment using a VSB demodulation method.

[Fig. 6]

It is an explanatory view showing an operation of a reflection distortion calculation circuit provided in the terminal equipment.

[Fig. 7]

It is an explanatory view showing an operation of an S/N calculation circuit provided in the terminal equipment.

[Fig. 8]

It is a block diagram showing a constitution of a terminal equipment using a QAM modulation method.

[Fig. 9]

It is a graph showing a state in which a noise is mixed in a multiplexed transmission signal.

[Fig. 10]

It is a graph showing a relation between an SN ratio and an error rate according to a multivalued level of the QAM modulation.

[Fig. 11]

It is a graph showing a relation between distortion and picture quality with respect to an output power of an LD of a light source.

[Fig. 12]

It is a graph showing a state in which a noise and distortion are mixed in a multiplexed transmission signal.

[Fig. 13]

It is a block diagram showing another constitution example of the terminal equipment using the VSB modulation method.

[Description of Reference Numerals]

110 … Analog signal generation unit (first output unit)

120, 130 … Digital signal generation unit (second output unit)

121 … Multilevel QAM modulator (multilevel modulation circuit)

131 … Multilevel VSB-AM modulator (multilevel modulation circuit)

200 … Switching circuit (setting circuit), 201 … Slicer circuit

202 … Mapper circuit (mapping circuit)

203Q, 203I … FIR filter circuit (filter circuit)

205 … D/A conversion circuit (converter circuit)

206 … Orthogonal modulator (orthogonal modulation circuit)

Fig. 1 Fig. 11

1 Center equipment

2 Downlink

3 Uplink

4 Distortion

5 Picture quality

6 LD output power

Fig. 2 Fig. 12

1 Level

2 Uplink

3 Existing TV broadcast

4 Multilevel VSB-AM digital signal

5 Multilevel QAM digital signal

6 Frequency (MHz)

Fig. 3

7 Analog video signal

8 VSB-AM modulator

9 Frequency converter

10 Frequency multiplexer

11 Level adjuster

12 Multilevel QAM modulator

13 Digital signal time multiplexer

14 Multilevel VSB-AM modulator

15 Database

16 Center controller

17 Receiver

Fig. 4

18 Digital video signal

19 Slicer circuit

20 Mapper circuit

21 FIR filter circuit

22 Orthogonal modulator

23 To frequency converter

24 Q axis

25 I axis

26 To clock terminal

27 QAM/VSB switching circuit

28 Factor setting circuit

29 FIR factor "a"

"b"

Fig. 5 Fig. 13

1 Tuner

2 IF signal

3 VSB demodulator

4 Equalizer

5 Error correction circuit

6 Failure detection lineage

7 Error rate calculation circuit

8 Transmitter

9 Reflection distortion calculation circuit

10 S/N calculation circuit

11 Communication control circuit

12 Input/output

Fig. 8

13 QAM demodulator

14 Synthetic circuit

Fig. 9

15 Level

16 Existing TV broadcast

17 Multilevel VSB-AM digital signal

18 Multilevel QAM digital signal

19 Frequency

Fig. 10

20 Error rate

21 SN ratio

Fig. 13

1 Tuner

2 IF signal

3 VSB demodulator

4 Equalizer

5 Error correction circuit

6 Failure detection lineage

7 Error rate calculation circuit

8 Transmitter

9 Reflection distortion calculation circuit

10 S/N calculation circuit

11 Communication control circuit

12 Input/output

Ref. 2

適用できる。

【００５９】

【発明の効果】以上説明したように、各請求項にかかる画像伝送装置によれば、多値ＶＳＢ－ＡＭ変調及び多値ＱＡＭ変調のいずれにも対応し得る第２出力部を備えて構成したので、同一の伝送ネットワーク内に、ＱＡＭ復調方式とＶＳＢ復調方式との異なるタイプの加入者端末装置が混在する場合にも、各方式の加入者数の増減に応じて、画像伝送装置の変調方式の変更を容易に行うことができる。

【図面の簡単な説明】

【図１】本実施形態にかかる画像伝送装置を備えたＣＡＴＶ伝送システムの構成を概略的に示すシステム構成図である。

【図２】伝送される各信号の伝送帯域を示す説明図である。

【図３】センター装置の構成を示すブロック図である。

【図４】多値変調部（多値ＱＡＭ変調部及び多値ＶＳＢ－ＡＭ変調部）の構成を示すブロック図である。

【図５】ＶＳＢ復調方式を適用した端末装置の構成を示すブロック図である。

【図６】端末装置に備えられた反射歪計算回路の動作を示す説明図である。

【図７】端末装置に備えられたＳ／Ｎ計算回路の動作を示す説明図である。 ＊

＊【図８】ＱＡＭ変調方式を適用した端末装置の構成を示すブロック図である。

【図９】多重伝送信号にノイズが混入した状態を示すグラフである。

【図１０】ＱＡＭ変調の多値レベルに応じた、ＳＮ比と誤り率との関係を示すグラフである。

【図１１】光源となるＬＤの出力パワーに対する、歪みと画質との関係を示すグラフである。

【図１２】多重伝送信号に、ノイズと及び歪みが混入した状態を示すグラフである。

【図１３】ＶＳＢ変調方式を適用した端末装置の他の構成例を示すブロック図である。

【符号の説明】

１１０…アナログ信号発生部（第１出力部）

１２０、１３０…デジタル信号発生部（第２出力部）

１２１…多値ＱＡＭ変調部（多値変調回路）

１３１…多値ＶＳＢ－ＡＭ変調部（多値変調回路）

２００…切り替え回路（設定回路）、２０１…スライサー回路

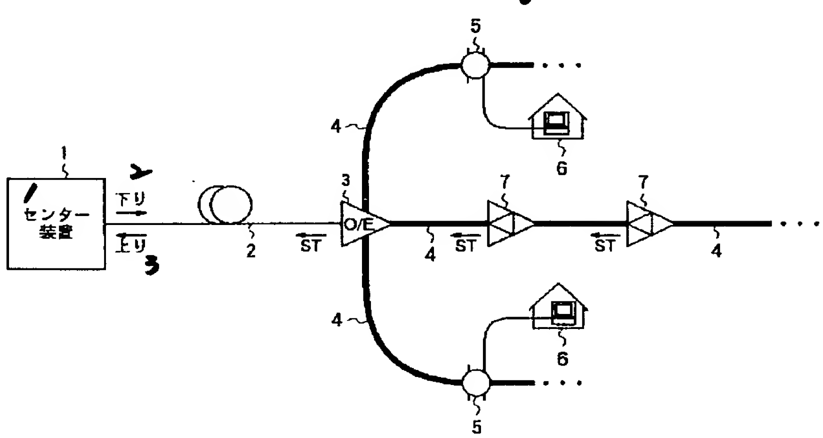
２０２…マッパー回路（マッピング回路）

２０３Ｑ、２０３Ｉ…ＦＩＲフィルタ回路（フィルタ回路）

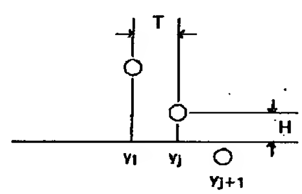
２０５…Ｄ／Ａ変換回路（コンバータ回路）

２０６…直交変調器（直交変調回路）

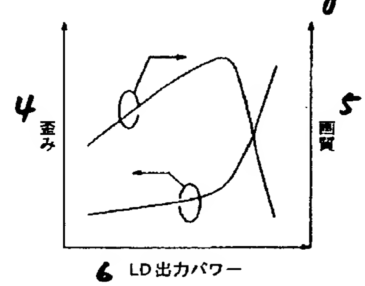
【図１】 Fig.1



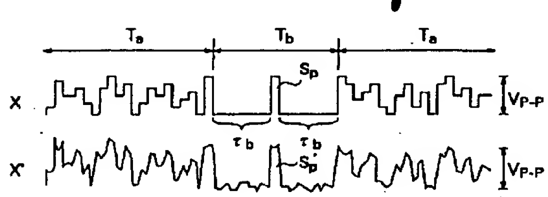
【図６】 Fig.6



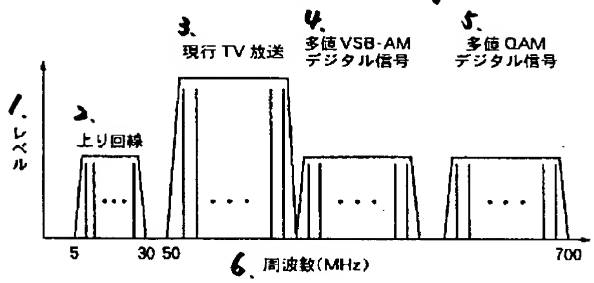
【図１１】 Fig.11



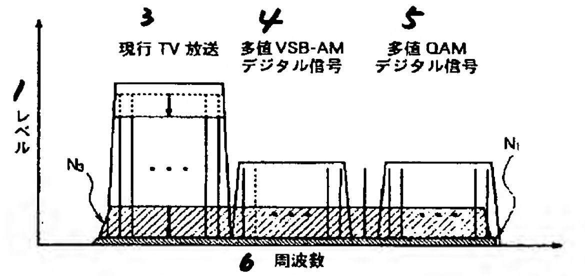
【図７】 Fig.7



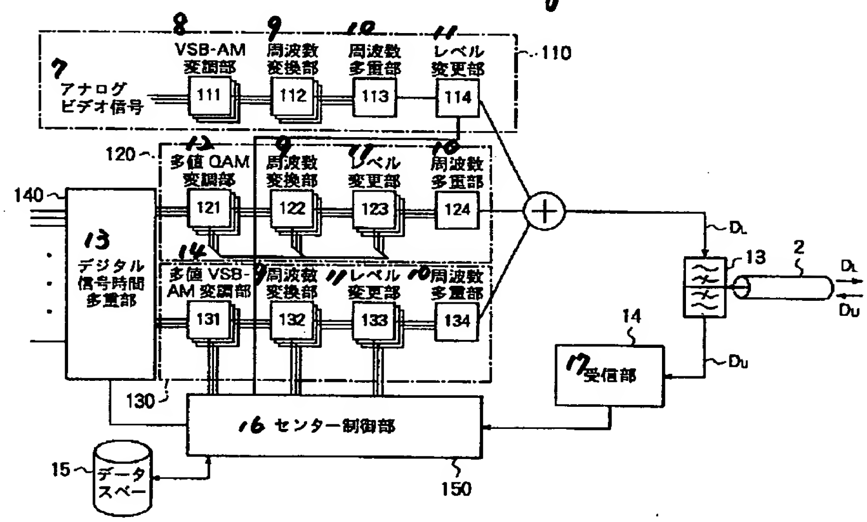
【図2】 Fig. 2



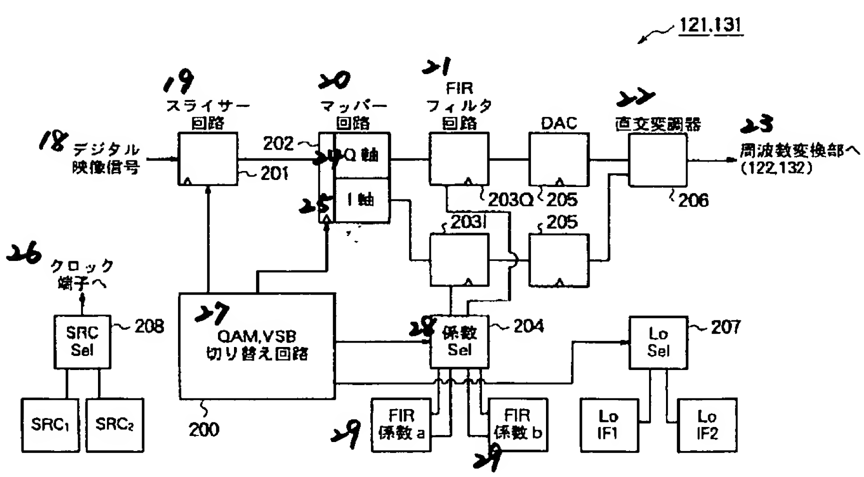
【図12】 Fig. 12



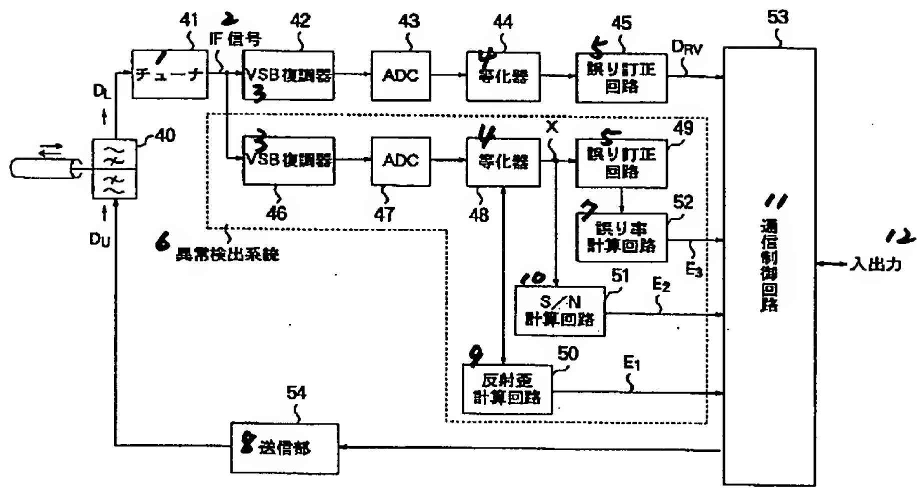
【図3】 Fig. 3



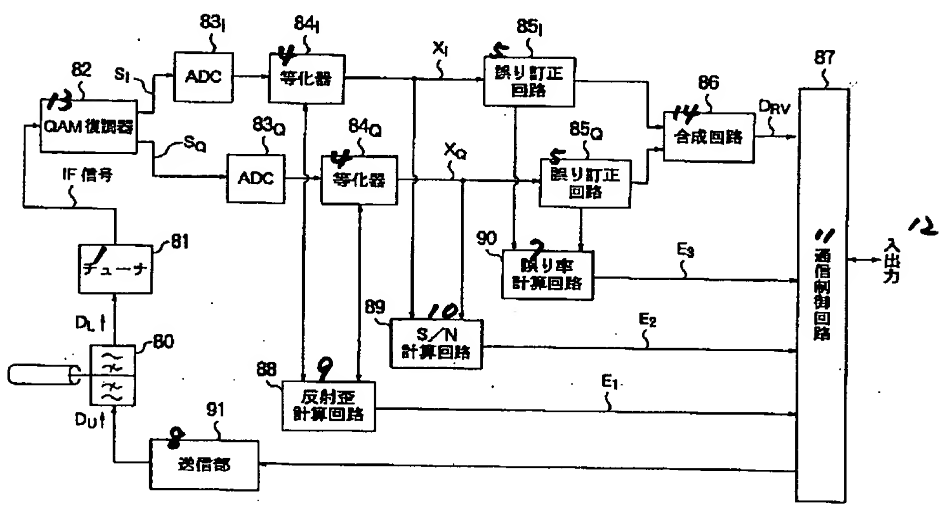
【図4】 Fig. 4



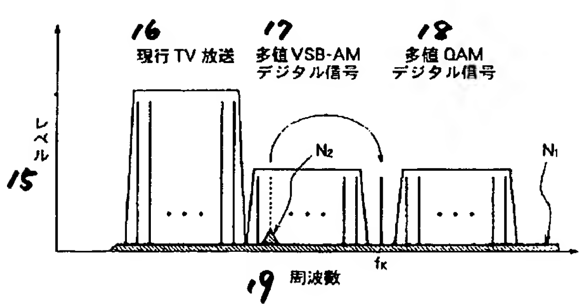
【図5】 Fig. 5



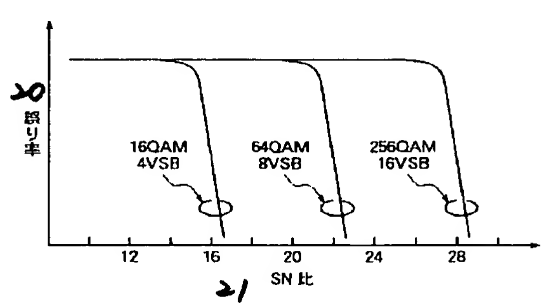
【図8】 Fig. 8



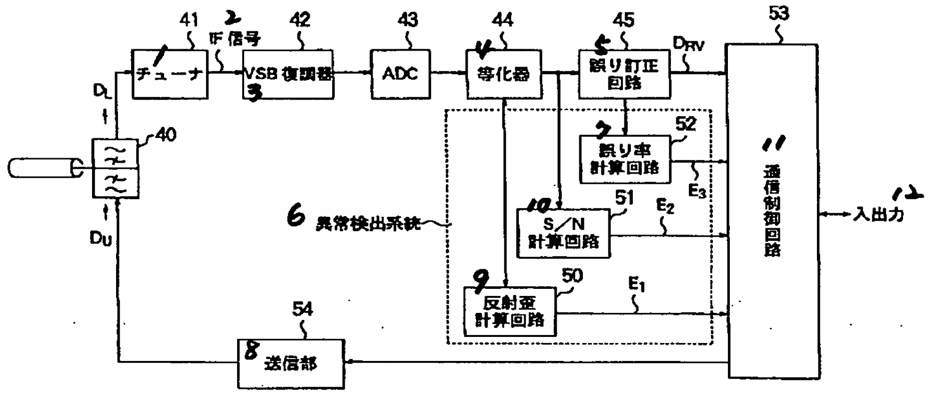
【図9】 Fig. 9



【図10】 Fig. 10



【図１３】 Fig. 13


41
IF信号
42
43
44
45
53
チューナ
VSB復調器
ADC
等化器
誤り訂正回路
D_{RV}
D_L
40
D_U
52
誤り率計算回路
E_3
51
S／N計算回路
E_2
異常検出系統
50
反射歪計算回路
E_1
通信制御回路
入出力
54
送信部